

SECRET

2

- (b) Inspect all riveted or welded seams to find any visible defects.
4. Compartments are not painted before inspection. In order that the compartment will not be deformed during the testing, temporary reinforcements are installed. The joined edges of the construction and the rivet heads must be cleaned so that defects may be found more easily. For convenience's sake scaffolds and ladders are arranged to permit inspection of the entire hull and are set in such a way that they do not conceal any points that must be inspected. Any parts of the hull which are to be tested for watertightness usually are not cemented, asphalted or painted until after the examination. If the hull is painted to protect it from corrosion the paint must be cleaned off the welded and riveted edges before inspection.
 5. Since the walls of each compartment must be watertight, they are tested by allowing water to run into each compartment one at a time. If the hull is afloat at the time of testing care must be taken to insure that the valves in each compartment are closed.
 6. Pressure pipes coming out of one of the manholes of the compartment being tested should be installed up to the required height on a temporary cover. In place of a pressure pipe, a rubberized hose can be used. It is easily installed and raised to the correct height. The hose should be not less than 75 mm in diameter. These hoses should be completely waterproof so that the moisture from the compartment doesn't interfere with the work of the caulkers and other workmen.
 7. The testing must be done quickly, and filling the same compartment with water more than once should be avoided. The repeated filling of a compartment with water may produce deformation due to the settling of the props. A prolongation of work in one compartment holds up work in the neighboring compartments. Special attention must be given to the testing of double-bottom compartments.
 8. In the construction office of every factory or shipyard there is a testing chart for all compartments to be tested with water, showing the exact water pressure for each one. The tests are carried out very systematically.
 9. At present there are several methods of testing compartments and other parts of the hull for watertightness:
 - (a) By completely filling the compartment with water or oil.
 - (b) By filling the compartment with water or oil (in special cases heated oil is used) and raising the pressure by means of a column of liquid, as long as the pressure does not exceed 1.5-2 times the atmospheric pressure.
 - (c) By raising the water or oil pressure in the compartment by means of a pump, provided that the compartment is supposed to be tested under high pressure. Sometimes submarines are tested by the application of external pressure. This type of testing is done in a chamber dock. Testing done in the chamber dock is carried out by special instructions drawn up by the factory with the concurrence of the ordering company.
 - (d) By air pressure (in testing for gastightness).
 - (e) The remaining parts of the hull - the shell plating, the transversal and fore and aft bulkheads, decks, platforms,

50X1-HUM

SECRET

SECRET

3

etc., are tested by means of a stream of water from a fire pump with a pressure of 2-2.5 times the atmospheric pressure.
(f) By observing the effect of a stream of compressed air directed against one side of a seam upon a candle flame held up to the opposite side of the seam. This last device is used when it is difficult to make a hydraulic test.

10. Welded seams on prefabricated sections are tested by smearing the outer side of the seam with a chalky substance and the inner side with kerosene. The appearance of dark spots on the chalky substance will indicate where re-welding is needed.
11. Welded constructions undergo a test for airtightness first. The seams are smeared with a soapy substance in order to make this test. Seams not having any cracks but which let in air through pores (0.5 mm) can be fixed by beating with a hammer. Seams showing cracks must be cut out and rewelded. To test the quality of welded seams, holes are drilled in various sections of the seams. After being tested with air, the welded construction is given a hydraulic test in which the dry side of the seam is smeared with chalk to show any leakage of water.
12. As a control in testing, the X-ray and the magnetic defectoscope have come into use lately. The X-ray method has attained the widest use in the shipbuilding industry.
13. All watertight hatches, doors, and other details should be installed and battened down before the test begins. Their watertightness is tested at the same time as that of the compartments. Port lights, roofs, upper deck hatches, doors in the superstructure, etc., are tested by streams from fire pumps. Inspections of pipe junctions and wells are done separately, although the necessary fittings should be in place.
14. The fore and after peaks, and the ballast and oil tanks are tested with water. In order to get a corresponding pressure after the compartments have been filled, a temporary cover is placed over one of the hatches and a pressure pipe is installed. As soon as the water appears at the level of the air hole, it is closed with a wooden stopper. Further pumping of water into the compartment is done through the pressure pipe which has a funnel installed in it. The pressure attained by use of the pressure pipe usually is not more than 1.5 times that of the atmosphere. In order to achieve higher pressures of the type used in the testing of submarine hulls and tanks, the hydraulic press is used. In this case a water pressure gauge must be used. The caulkers are placed so that they can easily see leaks and plug them up at once. Every compartment should be under the observation of one or two caulkers. The seams are inspected from the front or riveted side.
15. During the test there are what may be called "air pockets" under the second bottom, platform or deck bordering the tested compartment on the top side. Holes are drilled in the upper floors and stringers to dissipate these pockets by allowing the free flow of air. If these pockets are not eliminated the compartment is not filled with water and the test must be made again. Sometimes, instead of drilling holes certain rivet holes are simply left unriveted. The compartment being tested must be completely accessible from all sides for caulking. Before testing, engine seatings, pipe conduits and other installations which might interfere with the caulkers' work are not installed. If difficulty is experienced in

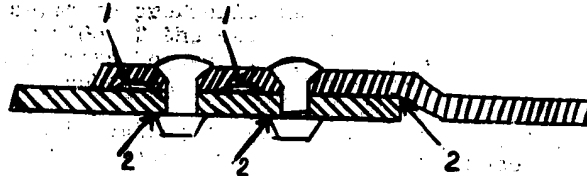
SECRET

SECRET

4

discovering the exact position of a leak in a riveted seam, the seam is smeared with lard.

16. In a thinly joined seam, as is shown in the drawing below, a canal is formed through which water runs. Such a canal must be eliminated. Arrows numbered 1 indicate these canals. Arrows numbered 2 show how the water runs into the canals.



17. When an air pocket forms, due to a badly placed air hole, the air gradually changes into liquid. The formation of such a pocket is discovered by beating on the top of the compartment and listening to the sound produced. Such a pocket is eliminated by knocking out a rivet or drilling a hole in the topmost part of the compartment.
18. In rare cases liquid escapes from the compartment through canals formed by unfinished connections of the plates. Therefore it is necessary to carefully inspect all connections in which such a canal might appear.
19. Defects in riveted seams must be repaired at once. Usually the defective rivet is drilled out and replaced but sometimes it is rolled in. All these repairs take place as soon as the water or air is released from the compartment. In very rare cases an experienced caulker can repair defects while the compartment is under pressure but only if the pressure does not exceed 1.5 times that of the atmosphere. Repair under pressure is not done often because in adverse circumstances a seam might develop still more defects. The appearance of individual drops of moisture on the outside of the compartment is not considered a leak.
20. When water is being pumped into a compartment there are some parts of the hull (bulkheads, platforms, etc) which occasionally bulge under the pressure. If these parts are constructed correctly they will resume normal shape when the pressure is withdrawn.
21. In order to check on the calculations of the designing office, especially in case of an experimental construction, an inspection is made to see if there is any residual defect. Before the test the bulkheads and platforms are inspected carefully and horizontal and vertical wooden measuring sticks are installed. By measuring the distances between various points on the bulkhead or platform and the measuring sticks, before and after the test of the compartment, the extent of deformation is determined.
22. In order to drain the water out of the compartment after it is tested, not more than two holes are drilled in the bottom of the compartment. These holes are then closed by inserting threaded plugs.
23. If, in a compartment which is being tested for oiltightness, the oil level begins to drop and there is no sign of a leak anywhere, that is a sign that oil is getting cool and consequently decreasing in volume. The oil should be kept heated

SECRET

SECRET

50X1-HUM

5

to a temperature of 50°C.

24. Tests for gastightness are made by air. Temporary covers are secured to the compartment being tested and a rubber hose with a pressure gauge in it is installed in the cover. Air is taken from air mains if the pressure is sufficient or from air pumps when a higher pressure is required. The air pressure is regulated by an air cock on the air hose and is measured by the pressure gauge. When the air pressure is at the required level, the caulkers inspect the outer sides of the compartment by smearing a soapy substance on the grooves, joints and rivets. If air is escaping, bubbles appear in the soapy substance. The leaks are marked and repaired after the air is released from the compartment.
25. When testing must be done in temperature below 0°C the water must be heated to a point where the interior of the compartment will be kept at not less than 5°C. When the temperature goes below -15°C testing is not recommended at all. At present, water for testing is heated by means of a coil that carries steam into the compartment being tested. The steam is supplied either by a railroad crane or by a special boiler rigged for that purpose. Electric water heaters are not used in the USSR. When water from a fire pump is used it is necessary to heat two compartments with steam first. In adverse circumstances water will freeze as soon as it hits the unheated metal plates. The compartment next to the one filled with water, that is, the compartment from which the inspection is being conducted, has to be heated or the seams will be covered with condensation, a condition which interferes greatly with the examination.
26. In every inspection for watertightness there is a book telling the date of the test, duration of the test, a plan for the testing of each compartment, size of compartment, pressure to be used, temperature of the water and results of the test. As the compartments are completed they are checked off in the book. The technical control section of the factory (OTK) takes the compartment from the shop and presents it to the representative of the orderer.
27. The new rules on testing provide for the testing of the outer plates, and deck by sections, a provision which is very important in the prefabricated building of ships. According to these rules also, tests for oiltightness may be conducted with water as long as the pressure is brought to the required point. Oil and fuel cisterns must be retested after they are installed on the ship. For this purpose compressed air is used. A pressure equal to that of water is used for the bottom compartments and half as much pressure is used for the other compartments. Parts of the hull bordering on the oil and fuel cisterns should be tested in the process of construction. The air tests conducted in this connection are done not only with soapy water but with the aforementioned flame process for determining if leaks are present.
28. It has been established by the rules that all the enumerated tests are for tightness but not for durability, in other words, a seam containing defective welding, gas inclusions, cracks and other defects may be tight but not always durable.
29. The durability of correctly planned welded hull constructions, prototypes of which have been used operationally, cannot be considered as tested after tests have been made for tightness, because it is impossible to test a welded seam for durability by making an external examination for tightness. For this reason the rules do not allow the testing for durability of

SECRET

50X1-HUM

SECRET

6

one part of the ship construction as this does not guarantee the durability of the other parts which have not been tested for durability.

30. The rules require a careful testing of the welded seams for any kind of imperfection.
31. In recent years the water test has been replaced on mass produced ships by post operational and preventive control of the hull quality, by air and pressure tightness tests and by supplementary control of the quality of welded seams. The water test has been discontinued in mass produced ships in order that the assembly work can be broadened in its earlier stages with a view to shortening the overall construction cycle.

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50X1-HUM

SECRET